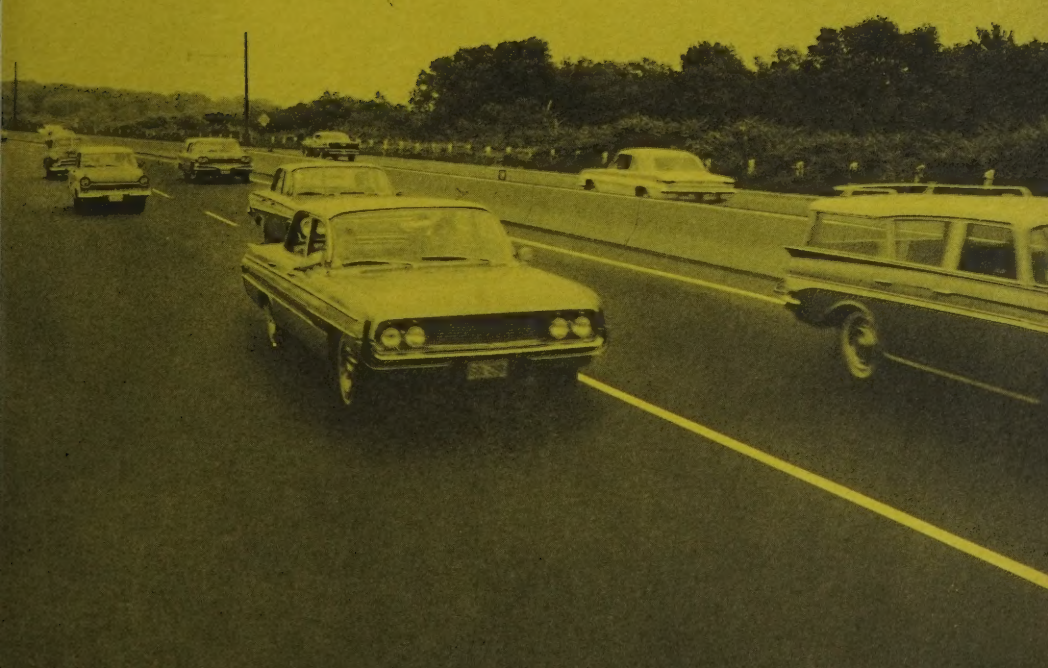
NEW JERSEY STATE HIGHWAY DEPARTMENT
SAFETY THROUGH ENGINEERING

CENTER BARRIERS

SAVE LIVES



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FOREWORD

Under the leadership of Governor Richard J. Hughes, the New Jersey State Highway Department has responsibility for providing highways and attendant facilities insuring the safe and convenient movement of people and of goods. In a State as urban as New Jersey, with traffic volumes five times the national average, no element outranks the importance of highway safety. In recent years, New Jersey has succeeded in reducing the fatality rate on the State Highway System from 5.3 deaths for every 100 million miles of travel in 1954 to 3.71 deaths in 1960. This achievement was possible only by aggressive attention to all phases of safety, especially those attainable through construction engineering.

In the case of new highways, no effort is spared to make them as accident free as possible through control of access, wide lanes and shoulders, and broad center islands wherever physical conditions permit. On the older, overburdened main highways, a continuing modernization program is under way. Closure of center island openings, erection of center barriers and other improvements are constantly in process.

The use of median dividers, or center barriers, is vital to the success of any safety program on heavily travelled highways which are limited in width. It has been proven that center barriers prevent fatal accidents.

From the economic point of view, the existence of a modernized, safe highway has always improved that area's general business climate.

For these and many other reasons, the New Jersey State Highway Department presents the story of how these effective safety devices were developed, and why they must retain their position in the forefront of our State's "Save Lives" program.

Dwight R. G. Palmer

Commissioner

New Jersey State Highway Department

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Development of the narrow median

Safety Curb in New Jersey

With the development of motor vehicles capable of comparatively high cruising speeds, highway engineers have faced an ever-increasing need for designs which will minimize the peril of accident and death. Nowhere is this need more acute than on crowded urban highways where head-on collisions are a constant danger.

Traffic safety experts have long recognized that the safest design for modern, multi-lane highways calls for the opposing lanes of traffic to be completely separated by very wide median strips. For example, figures compiled by the Bureau of Planning and Traffic show that on New Jersey's four-lane undivided highways, 1.41 times as many accidents, 1.45 times as many injuries and 1.64 times as many fatalities occur as on the State's divided highways.

In rural or comparatively undeveloped areas, the problem presented by the need to separate opposing traffic is not difficult. A median strip or "center island" several hundred feet wide virtually eliminates the possibility of an accidental crossing into an opposing traffic lane. But in an urban area, where a freeway passes through the heart of a major metropolitan complex, right-of-way widths are understandably restricted. Likewise, narrow medians are sometimes forced on the designer in areas where deep cuts or high embankments are necessary, and within the complicated interchanges of today. In such cases, a protective design is required to prevent vehicles, in the event of accident or loss of control, from going across opposing traffic lanes and to eliminate, as far as humanly possible, the danger of head-on collisions.

This element of design is crucial not only in the construction of entirely new highways in congested areas, but also in the rehabilitation of existing roads which are carrying traffic volumes far in excess of their planned capacity. With built-up areas crowding both sides of the right-of-way, the addition of extra traffic lanes is a difficult task. At times, the only solution is to do away with an existing center island and utilize a center barrier in its place.

New Jersey, the most urban State of the Nation, pioneered in design of divided highways and as a result has had many years of experience with narrow medians.

Experience proves a grass median of 20 feet or less in width is easily crossed. It is also subject to occasional misuse by those who make illegal "U" turns.

The testimony of comparatively narrow center islands has convinced the New Jersey State Highway Department that any median must take care of (1) the vehicle that might cross the median and, (2) the vehicles which might enter the median at a glancing angle. To

handle the latter possibility the desirable design is such that most vehicles would not be damaged or any injury result to the occupants.

One of the early designs consisted of a sloping concrete curb with a rounded, grassed median. It was reasonably satisfactory for a number of years when traffic volumes and speeds were lower, but is not suitable for present traffic conditions.

In early 1955 the Highway Department installed several types of barriers on N. J. Route 4 in an existing narrow center island which had concrete curbs at each edge. These experimental barriers consisted of wire cables, concrete beams, steel beams, 12-inch high concrete curb, and an 18-inch high parabolic concrete curb.

However, continued observation after construction showed that the outlying curb caused vehicles to continue to strike the center barriers in an unfavorable manner.

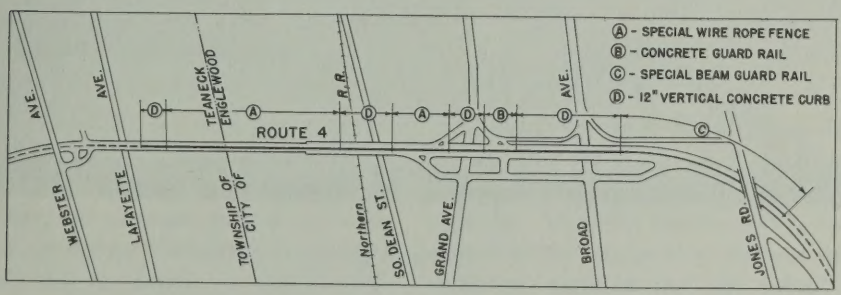
Also, a driver, after mounting the low curb, might be thrown about sufficiently to prevent regaining control of the vehicle. Police reports verified these observations and any curb or berm standing away from the base of a center barrier is an outmoded design.

A study of the accident records does not indicate that there is any basis for the theory that the center barriers, while eliminating head-on collisions, might cause a number of same direction accidents.

Police officials are unanimous in stating that they feel the barrier to be the greatest safety factor yet introduced on highways they regularly police and they find the barrier eminently successful.

The Department started use of the barrier curb program eight years ago and is making installations, not only on our older highways but also on our new state highways and freeways. A considerable mileage of our interstate routes in metropolitan areas will have barrier curbs.

Route U. S. 22 is one of the older highways in the State. The eastern section operates at absolute capacity and carries a high percentage of trucks. It had a curbed center island about nine feet in width. This island was replaced by a 20-inch high parabolic concrete curb after the installations on Route 4 were tested. The shape of this curb, curving down and out from the top, was determined by the distance the body of a vehicle normally projects beyond the left wheels. The curb was shaped so that no part of the body of the car



would hit the curb at flat angles of impact.

It was recognized that over a period of time many thousands of vehicles would hit this curb and many complaints would result if the barrier damaged every vehicle which struck it. Such damage could result in numerous injuries or possibly even fatalities. The theory was adopted that a barrier which could function satisfactorily under the conditions existing on Route U. S. 22 would work anywhere.

Figure 1 illustrates the design of this barrier curb. Drivers have not hesitated to ride very close to it. Figure 2 shows vehicle placement at night.

ACCIDENT COMPARISONS

Accident records on this section of highway (Newark, Hillside and Union) before and after installation of the barrier were studied. In Hillside alone, there were 11 fatalities in the three years preceding installation of the barrier. There were 15 head-on collisions in the same area in just one year - 1955. During the 42 months after the barrier was installed there was only one fatal freak accident.

A dramatic item was the reduction in the number of injury accidents involving the center strip. In the 18-month period before installation there were 24 injury accidents, compared with only 16 for

Figure 1

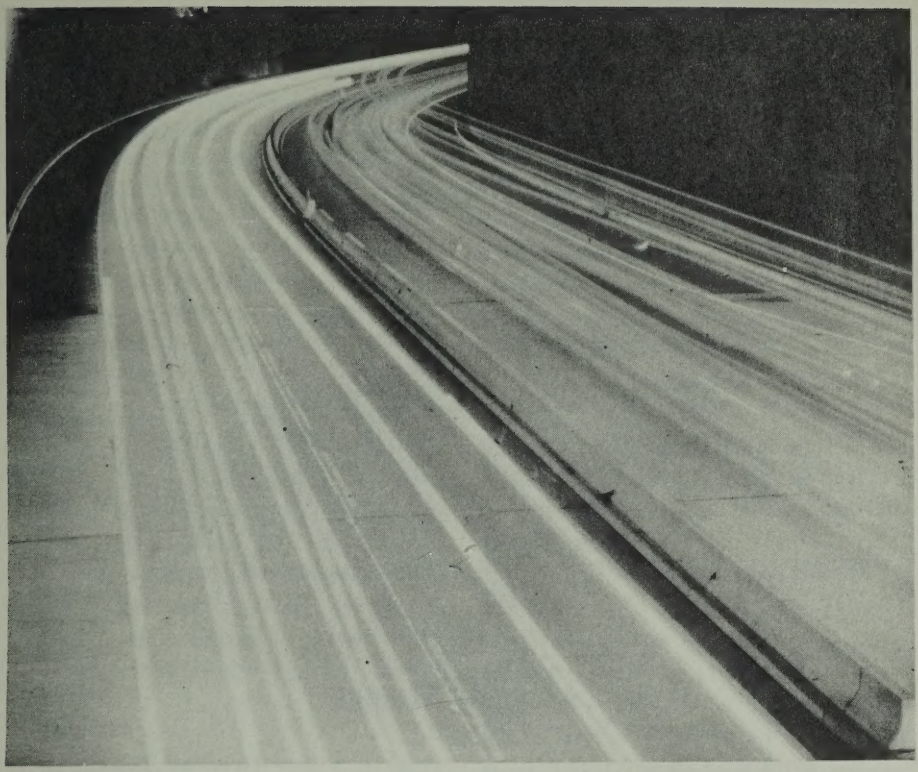


Figure 2

the entire 42-month period afterward. On a yearly basis, this was a reduction in injuries to one-fourth of what they were before the protection of the barrier curb was available.

The test of any median divider is what happens to vehicles after they hit it. With this thought in mind, the total of 75 accidents involving vehicles which hit the center barrier during the 42-month "after" period were studied in detail.

Accidents in which a vehicle hits the barrier and then is hit in the rear by another, for example, indicate that the speed of the vehicle hitting the barrier is reduced so quickly or that the following vehicle is so close that a rear end collision cannot be avoided. This defect in design would show up quickly on a route like U. S. 22 which operates at absolute capacity.

Of the 75 accidents involving the barrier it was found that there were only four in which a vehicle struck the divider and then was hit in the rear by another vehicle. These four accidents resulted in only one injury.

Next, the type of accident in which a vehicle hits the barrier and then strikes another vehicle on the side were considered. This was regarded as a matter of prime importance because such collisions indicate that the vehicle is

either being deflected by the barrier too rapidly or is knocked out of the driver's control.

Of the 75 accident total it was found that there were only seven of this type which resulted in only two injuries.

And last, there are vehicles which strike the barrier and then hit another car in the rear. A large number of accidents of this type would indicate that the barrier design is defective.

The design must be such as to enable a driver to retain control of his vehicle after impact and this includes ability to apply the brakes in time to avoid striking another car in the rear.

Again, of the 75 accident total, there were only five in which a vehicle hit the barrier and then hit another vehicle in the rear, and this resulted in only one injury.

A positive medium divider makes the serious cross-median type accident a very rare or freakish occurrence. However, by its very nature, the barrier restricts the distance a driver can move to the left. Some have believed that a center barrier might thus cause an abnormal increase in rear end accidents, but in areas where they have been installed local law enforcement officers say the barrier has not.

Were the barrier in fact causing an

ACCIDENT STUDIES

Route 4 in Teaneck — there were 16 head-on accidents resulting in 28 injuries and 2 fatalities in the one-and-a-half year period from July 1954 through December 1955, when a center barrier was completed. There were only 8 head-on collisions resulting in only 3 injuries and 1 death in the four year period from 1957 through 1961. This is only half as many accidents in more than twice the time.

Route 4 in Englewood — there were 25 head-on accidents resulting in 37 injuries and 5 fatalities in the three year period from 1952 through 1954, when a center barrier was completed. There were only 6 head-on collisions resulting in only 5 injuries and 1 death in the seven year period from 1955 through 1961. This is only a fourth as many accidents in more than twice the time.

Pulaski Skyway (Routes U. S. 1 & 9) — there were 367 accidents of all kinds resulting in 271 injuries and 8 fatalities during 1955 and 1956. There were only 172 accidents involving 106 injuries and no deaths in 1957 and 1958, after a center barrier was installed. This is less than half as many accidents with all deaths eliminated.

increase in rear end accidents, one of the places this would appear would be at interchange areas where old design, without acceleration or deceleration lanes, causes considerable traffic friction. There has been no evidence of an increase in this type of collision at such locations. In fact, as other studies by the Department and facts compiled indicate a reduction of all types of accidents can be anticipated.

A factor which must be considered in all comparisons of traffic accidents is the steadily mounting volume of travel. For this reason, studies have included accidents on two comparable highways after a center barrier was installed on one of them. During four years, total accidents on the highway without a center barrier increased more than three times as much as the highway which had a barrier.

These studies indicated that to reduce accidents and cut fatalities, it is desirable that all four-lane roadways have a center island of some type. Where right-of-way width is restricted, the island should take the form of a barrier curb to reduce head-on collisions.

In urban areas, with bridges close together, it is not desirable to vary the median width between bridges. For a barrier two feet wide at the base, this would result in a 5-foot paved shoulder on each side of the barrier between bridges. This is narrow enough to prevent misuse as a passing lane but does provide some elbow room for emergencies. A greater width would serve no useful purpose. Besides being wasteful, it could be a hazard.

The special study also covered the results of closing off openings in narrow center islands. On Route 4, in the two years before center island openings were closed in Paramus, there were 471 accidents of which 120 were accounted for by left turns. In the year after the openings were closed, there were only 75 accidents of which only 8 definitely involved left turns.

PROBLEMS ENCOUNTERED

However, other problems are created by a narrow median such as provisions for drainage and snow removal operations. With a wide median, the center island can be slightly depressed and used for snow storage and a drainage system.

With a narrow median, special consideration must be given to these problems. For snow removal, it is sometimes feasible to plow all snow to the right. If the depth of snow is not too great, it may sometimes be possible to store some next to the barrier. This is possible as Interstate Standards call for a minimum clearance of 3-1/2 feet from the travel lane to a point on the barrier where it is 12 inches high.

For four, or perhaps even six lane roads, consideration is given to sloping the lanes away from the center barriers.

This eliminates the necessity of a drainage system in the center. If this is not possible, special inlets are placed in the center.

One of the problems presented by a narrow median is the provision for official "U" turns. These are necessary for maintenance, police, fire, ambulance and other emergency use.

At some locations we have provided openings in the curb so that it can be crossed by official vehicles and erected a sign "For Official Use Only". These openings have operated satisfactorily but would not be suitable for many locations. The vehicle waiting to make a "U" turn is a "sitting duck" without protection from a rear end collision. Openings for "U" turns are not suitable for high volume or multilane facilities. A much better solution is to make the turn at a grade separation. This could be done at a structure (of open end design) over a stream, railroad or crossroad. A low clearance roadway could be built under the end span without substantially increasing costs. The under structure inexpensive type roadway for "U" turns would be connected to right-turn exit and right turn entrance to the through traffic lanes.

A 16-foot wide center island will permit a 12-foot wide left turn lane, curbed on both sides. For this reason, a 16-foot wide island was used in the American Association of State Highway Officials Policy on Geometric Design of Rural Highways.

In any design, a balance should be obtained. One element should not dominate at the expense of the others. In many instances too much attention is paid to the width of the center island, using the maximum amount of space there and then skimping on the treatment at the outer edges of the roadway. This, of course, stems from the fact that accidents which involve crossing of the median are spectacular and frequently result in multiple deaths.

NON-COLLISION ACCIDENTS

Between 30 and 35 per cent of the highway fatalities in the United States occur in non-collision accidents. Safety engineering studies have shown that off-the-road accidents were the most common, and almost every mile of the roads studied throughout the nation had one or more places where the occupants would suffer serious or fatal injury if the vehicles left the road at normal speeds.

The roadside treatment recommended as a result of these studies provides slopes flat enough so that a driver is not severely shaken up and can retain control of his car. A vertical rise of one foot in every six feet of horizontal distance would minimize impact and prevent car bumpers from digging in.

There may not be room enough for this type of design if the median is too wide. But a 100-foot center island should not be provided for the motorist who leaves the roadway from the left hand lane if this affords nothing but the width of the shoulder for the traffic on the right hand lane. In such areas use of a barrier curb in the center of the highway would permit proper treatment for the outer edges.

OTHER MEDIAN TREATMENT

The New Jersey State Highway Department also seeks to avoid that type of median treatment in which opposing roadways are placed at radically different elevations but close proximity to each other. A driver cannot retain control of the vehicle if it leaves the upper roadway under such conditions and a severe accident will probably result.

With the guard rail at the edge of the shoulder, there is no elbow room for emergencies. The guard rail itself is a hazard.

A vehicle that strikes it at anything except a flat angle, is almost certain to be pocketed by the post, with severe injury to the vehicle and occupants. A vehicle which breaks through the rail presents a serious hazard to traffic on the lower roadway.

With this design, most of the benefits of a center median are lost and additional hazards are introduced. As far as operation is concerned, it can be considered as probably the worst type of narrow median.

Construction and Use of

Center Barriers

Here is a pictorial explanation of the modernization of a principal highway through installation of a median divider showing phases of construction from beginning to completion. The safety value is self-evident in the final photograph.

This shows a typical section early in the construction phase. The first operation involves removal of center island top soil and curbing.

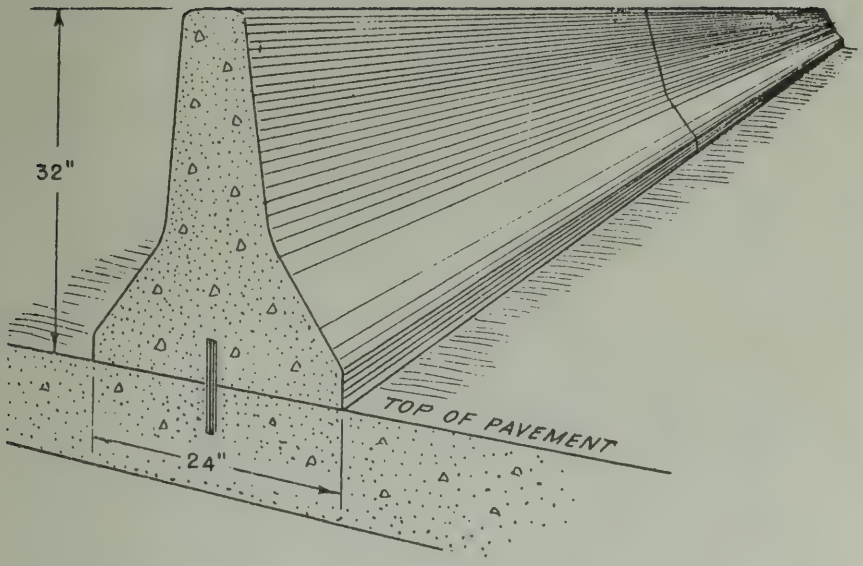
After removal of old center island is completed, subbase material is laid, over which a bituminous stabilized base and a bituminous concrete base course are placed. Workmen then position the lower rails of forms for construction of the barrier curb.

With upper sections of curb forms in place, the initial dump of gray cement has been made. Dowells have been inserted to provide a bond between the gray concrete and the white concrete which will be later placed to form the actual shell of the curb.

Once the white concrete has been placed, workmen finish the top surface of the barrier curb.

All forms being removed, the bituminous base is built up to the level of the old concrete pavement.

This photo shows completed highway after road has been black-topped and reflectors placed atop the barrier at 100 and 200 foot intervals depending on curvature and topography.



Present 32" High Barrier

The first concrete center barriers installed by the New Jersey Highway Department were 18 inches high. On the basis of experience, the design has been modified to a height of 32 inches and this design is under continuous study looking toward further improvement.

The type of barrier shown in the preceding photographs is 24 inches high and contains 2.93 cubic feet of concrete per lineal foot. The Department's latest 32-inch high barrier design contains 2.765 cubic feet of concrete per lineal foot, however, and costs about $10.75 per running foot. White concrete is used to accentuate visibility.

Despite acceptance of the safety center barrier program by traffic enforcement agencies, from time to time storms of opposition to its placement have arisen at some locations on the highway system. The impetus for each of these movements can usually be placed at the door step of emotionally misguided private interests that would rank the best interests of the many below those of relatively few.

When the broad view is taken, however, expressions concerning the center barrier are most favorable. Following are a few excerpts from the many expressions of individuals and organizations concerning center barrier installations on file with the Department:

April 16, 1955

The Bergen County Safety Council reports . . . .

The Council is pleased to see the improvements being made in Teaneck and Englewood to prevent cross-over median accidents. In addition, the Council voted unanimously to go on record and recommends that adequate barriers be erected from the George Washington Bridge to the Paterson City line.

June 13, 1961

Mr. H. E. Arigg, Director of Industrial Relations at P. Ballantine & Sons relates:

I was traveling 50 miles per hour east on Route 22 in the Weequahic Park section. Another car traveling west was also going the same speed. Both vehicles were about 100 feet apart when the left front tire of the other car blew out. This resulted in the car swerving sharply to the left, striking the dividing wall. Had it not been for the presence of this barrier, there is no doubt there would have been a head-on collision with unquestioned serious consequences.

October 17, 1961

Borough of Hasbrouck Heights resolves . . . .

That the N. J. State Highway Commission is requested to continue the center barrier on Route 17 through the Borough of Hasbrouck Heights in order to insure the orderly and safe flow of traffic.

Furthermore respective mayors from Carlstadt, Wood-Ridge, East Rutherford, Rutherford and Hasbrouck Heights have adopted plans to request construction of a center barrier in their five contiguous municipalities.

February 15, 1962

The New Jersey State Safety Council states . . . .

We are in full agreement with the proposed plans of the N. J. State Highway Department to erect medial barriers on all heavily traveled state highways and wholeheartedly endorse the improvements to Route 36 in Monmouth County.

August 1, 1962

The Burlington County Times editorializes . . . .

Route 130 Improvements To Benefit All In Area

Construction of the medial barrier along Route 130 has elicited mixed reactions from county residents and local businessmen. Officials of the various communities fronting the highway have shown some concern on two counts.

At a recent committee meeting in Delran, two committeemen discussed the problem from different points of view. One expressed concern for the business interests along the highway, apparently feeling that the concrete barrier, making crossing of Route 130 impossible except at jug handles, would ruin business along the highway.

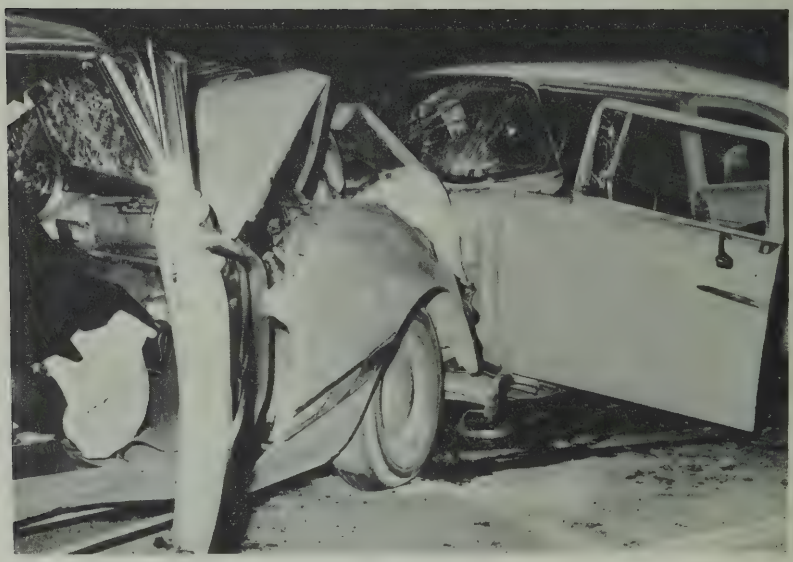
The second approach to the problem centered around safety aspects, as the local director of public safety indicated that the highway department was considering a plea for more emergency breakthroughs.

It must be kept in mind that there is nothing essentially incompatable in a safe Route 130 and prosperous commercial enterprise along the highway.

There are many motorists today who do not drive, and shop, along Route 130 simply because they, or their wives, are afraid to travel the road. Any improvement which can be made to the safety conditions along the highway will certainly be reflected in increased traffic.

The medial strip will not only severely cut down the possibility of head-on collisions but will also provide for three lane traffic in each direction of the highway — a condition that will certainly serve the best interests of safety as well as commercial activity.

Head On Collisions Can Be Prevented



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STATISTICAL APPENDIX

MARCH, 1966

CENTER BARRIERS SAVE LIVES

LOCATION on the NEW JERSEY STATE HIGHWAY SYSTEM

ROUTE	DATE (Bids Rec'd)	LENGTH (In Feet)	MUNICIPALITY (Twps., & Boros)
22	4/7/49	9,250	West Portal
46	5/6/53	7,762	Dunnfield & Columbia
3	7/27/54	2,391	Teaneck
22	8/31/54	20,479	Union, Hillside & Newark
4	2/3/55	5,563	Jersey City & Kearny
3	7/21/55	3,056	Paterson
1	11/29/55	10,155	Lawrence
4	1/10/56	11,708	Teaneck
3	1/24/56	1,555	Paterson
1	1/31/56	13,603	Kearny & Jersey City
38	4/17/56	2,639	Delaware
22	4/24/56	19,579	Mountainside & Scotch Plains
17	5/15/56	20,435	Paramus
42	5/29/56	3,066	Gloucester
4	7/3/56	4,630	Hackensack
206	7/17/56	2,993	Columbus
22	10/2/56	10,858	Newark
4	1/3/57	4,856	Fort Lee
130	2/19/57	27,067	Brooklawn & Bellmawr
21	6/13/57	4,826	Belleville
22	7/23/57	35,090	Green Brook & N. Plainfield
72	2/18/58	6,028	Stafford
4	7/8/58	11,746	Paramus & River Edge
42	7/15/58	15,969	Hamilton
1	7/23/58	32,151	S. Brunswick—N. Brunswick
S41	7/24/58	7,980	Palmyra, Pennsauken
46	7/31/58	4,564	Lodi, Hasbrouck Heights
3	9/16/58	4,577	Paterson
1	10/14/58	1,065	North Brunswick
1	10/21/58	17,877	Lawrence & W. Windsor
1	10/21/58	15,975	Plainsboro & S. Brunswick
1	11/12/58	14,950	W. Windsor & Plainsboro
1	1/20/59	13,830	Lawrence
18	3/10/59	5,003	New Brunswick & East Brunswick
30 & 295	5/20/59	2,599	Mt. Ephraim, Bellmawr, Haddon Hghts. & Barrington

ROUTE	DATE (Bids Rec'd)	LENGTH (In Feet)	MUNICIPALITY (Twps., & Boros)
287	6/4/59	2,044	Piscataway & Franklin
38	7/8/59	5,970	Delaware, Maple Shade
322	7/9/59	24,239	Hamilton & Weymouth
287	7/31/59	3,565	Bridgewater
1 & 9	10/21/59	13,538	Jersey City, Fairview
1, 9 & 46	10/21/59	8,604	Palisades Park and Ft. Lee
73	1/13/60	6,441	Pennsauken & Maple Shade
1	3/10/60	7,600	North Brunswick
4	4/6/60	7,825	Teaneck, Englewood, Ft. Lee
30	5/5/60	7,695	Camden
1, 9 & 46	6/22/60	12,300	Ridgefield—Ft. Lee
78	10/6/60	17,700	Bloomsbury, Bethlehem & Union
130	12/5/60	14,435	Burlington—Pennsauken
54	12/22/60	1,400	Hammonton—Buena Vista
18	1/19/61	3,147	Bound Brook & Bridgewater
80	1/26/61	1,457	Englewood & Leonia
130-206	4/27/61	1,135	Bordentown
80	6/29/61	5,038	Lodi, Teterboro, Hackensack
208	7/7/61	7,096	Franklin Lakes & Oakland
18	7/13/61	10,818	E. Brunswick & Madison
130	7/26/61	4,445	Bridgeboro—Camden
1	7/27/61	6,957	North Brunswick
80	8/8/61	5,258	Lodi
22	11/2/61	22,176	Bridgewater and Greenbrook
80	11/8/61	1,947	Hackensack & Ridgefield Pk.
80	11/22/61	3,128	Saddle Brook—Lodi
80	11/30/61	2,666	Paterson & E. Paterson
34-35	1/4/62	2,209	Wall
1	3/1/62	7,120	Edison & New Brunswick
130	5/10/62	49,000	Pennsauken, Cinnaminson Delran, Willingboro, Edgewater Park, Delaware & Burlington
18	5/31/62	4,926	East Brunswick
G. S. Pkwy.	6/21/62	5,400	Woodbridge, Clark, Union, Cranford & Kenilworth
287	6/28/62	2,253	Bridgewater
80	8/2/62	14,784	Hackensack—Teterboro
18	1/17/63	12,160	East Brunswick, Madison
80	1/22/63	21,120	Paterson, E. Paterson
3 & 20	2/7/63	1,800	E. Rutherford
38	2/28/63	13,728	Pennsauken, Cherry Hill
3	4/18/63	8,976	Secaucus, E. Rutherford
69 & 202	6/6/63	28,500	Raritan
10	9/19/63	8,215	Whippany & Hanover
1	10/10/63	4,593	Jersey City
35	5/14/64	2,270	Eatontown
69, 202	7/16/64	10,600	Raritan & Hunterdon
35	10/18/64	2,428	Keyport
36	1/28/65	26,400	Atlantic Highlands
9	2/4/65	2,597	Freehold
1	3/4/65	13,100	Metuchen
287	4/9/65	1,478	Elizabeth
1 & 9	5/6/65	2,640	Elizabeth
38	7/15/65	12,000	Maple Shade & Cherry Hill
Total		1,042,747	

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